NASA Centennial Challenges

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https://www.nasa.gov/winit

WHY “*CENTENNIAL CHALLENGES*”?

- Established to conduct prize competitions in support of the Vision for Space Exploration and ongoing NASA programs
- Although the first competition was started in 2005, development of the program started in 2003 to commemorate…

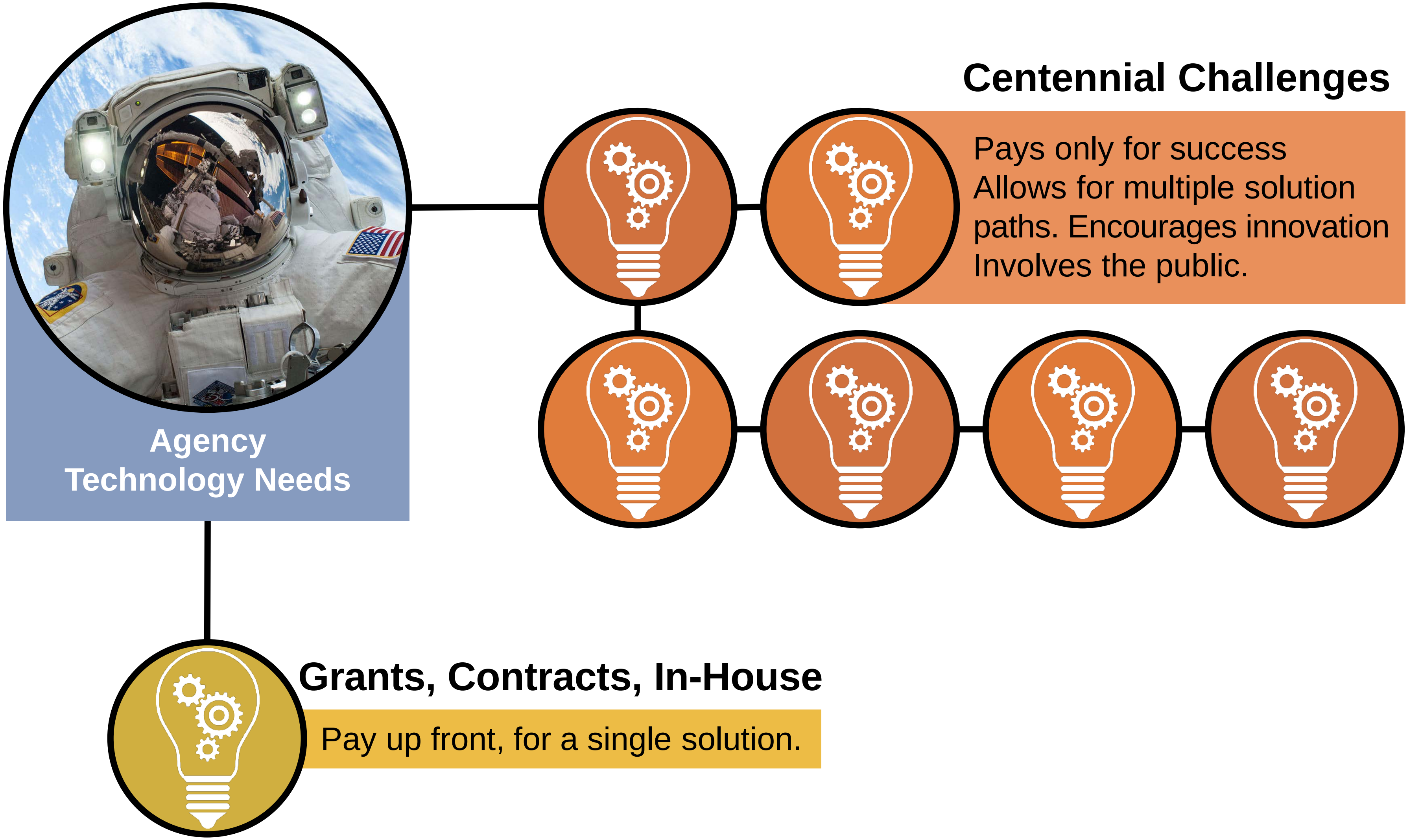
Centennial of Flight

The Wright “Flyer”

An aircraft built of wood, powered by hand made propellers flew at Kitty Hawk, North Carolina, on December 17, 1903, making a 12-second flight.

OVERVIEW OF PROGRAM

Why Centennial Challenges Works



Agency Technology Needs

Centennial Challenges

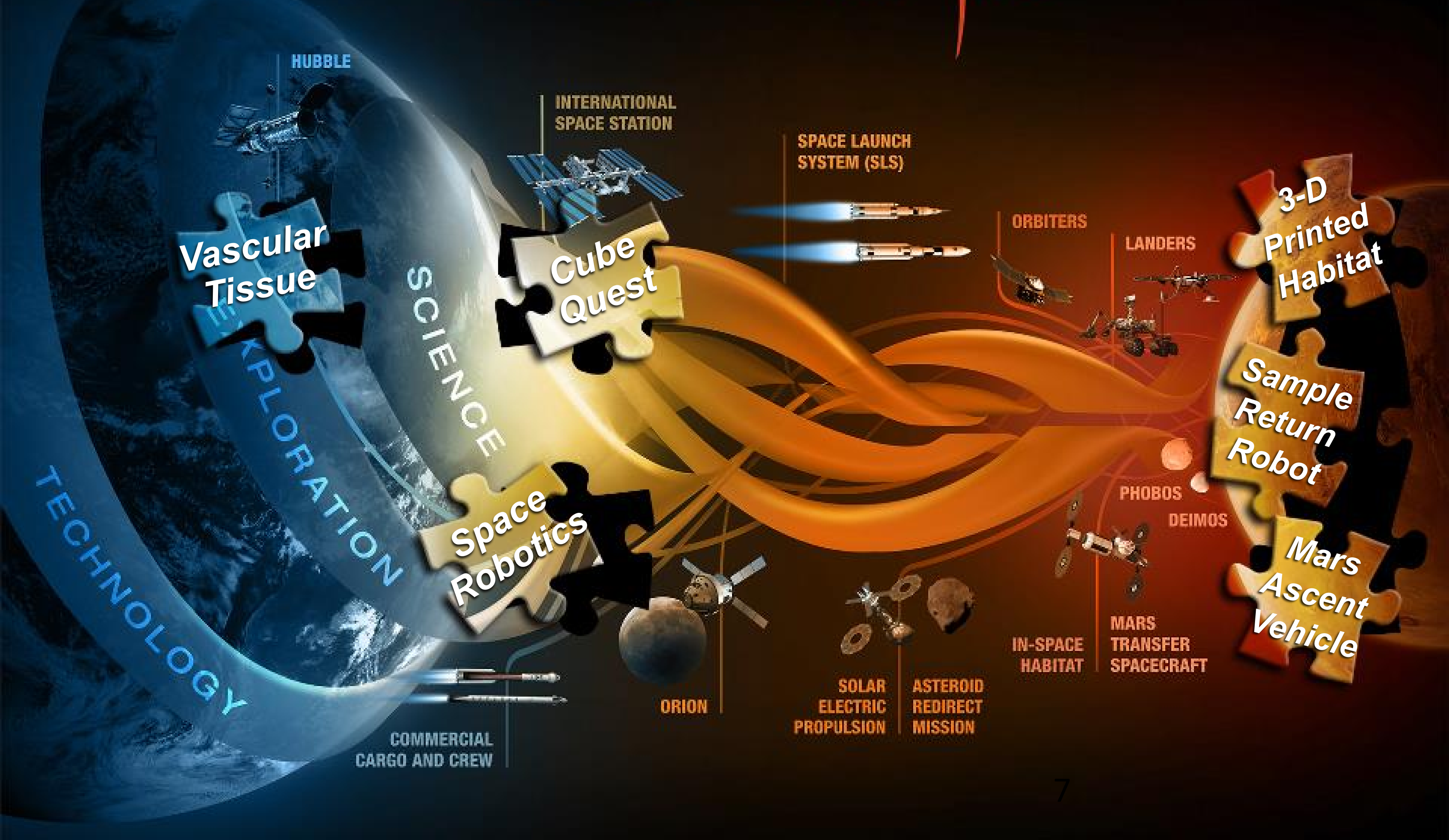
Pays only for success
Allows for multiple solution paths. Encourages innovation
Involves the public.

Grants, Contracts, In-House

Pay up front, for a single solution.

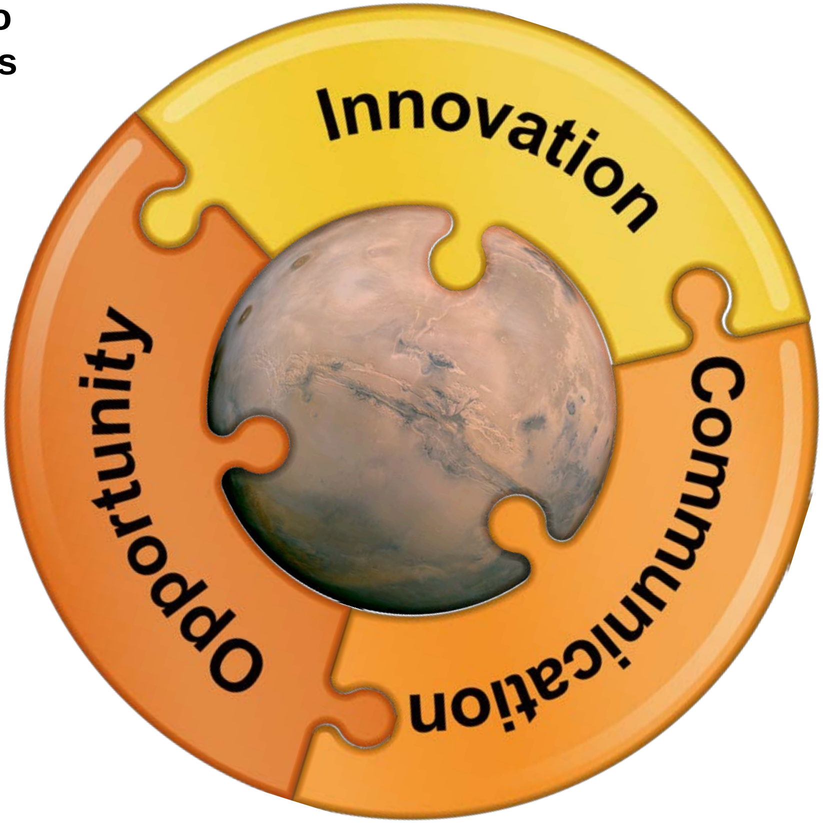
centennialchallenges…

…A Piece of Our JOURNEY TO MARS



- Citizens to contribute to NASA's Journey to Mars
- Maximize Agency's return on Investment
- Demonstrate technologies

- Seeks innovation from non-traditional sources
- Increases the pool of technology solutions
- Pushes the boundary of human potential



- Gets significant media attention
- Captures the public imagination
- Engages people and communities

Invites the Nation to be Part of NASA's Journey to Mars and Beyond…

Program Summary

Total Challenges (since 2005)	**18 Open** (4 never competed) Technology development areas including: propulsion, robotics, comm & navigation, human health, science instrumentation, nanotech, materials & structures, and aerodynamics
Challenges with Winners	**11** All challenges conducted in 2015-2016 awarded prizes Only Strong Tether never awarded prize money
Prizes	44 prizes awarded 35 different teams (8 repeat winners) Total Awards of $7.282 Million
Current Status	4 open challenges Cube Quest, Vascular Tissue, Space Robotics, 3D-Printed Habitat 6 challenges in development

☑ TA 1 LAUNCH PROPULSION SYSTEMS

☑ TA 2 IN-SPACE PROPULSION TECHNOLOGIES

TA 3 SPACE POWER AND ENERGY STORAGE

☑ TA 4 ROBOTICS AND AUTONOMOUS SYSTEMS

☑ TA 5 COMMUNICATIONS, NAVIGATION, AND ORBITAL DEBRIS TRACKING AND CHARACTERIZATION SYSTEMS

☑ TA 6 HUMAN HEALTH, LIFE SUPPORT, AND HABITATION SYSTEMS

☑ TA 7 HUMAN EXPLORATION DESTINATION SYSTEMS

☑ TA 8 SCIENCE INSTRUMENTS, OBSERVATORIES, AND SENSOR SYSTEMS

TA 9 ENTRY, DESCENT, AND LANDING SYSTEMS

TA 10 NANOTECHNOLOGY

☑ TA 11 MODELING, SIMULATION, INFORMATION TECHNOLOGY, AND PROCESSING

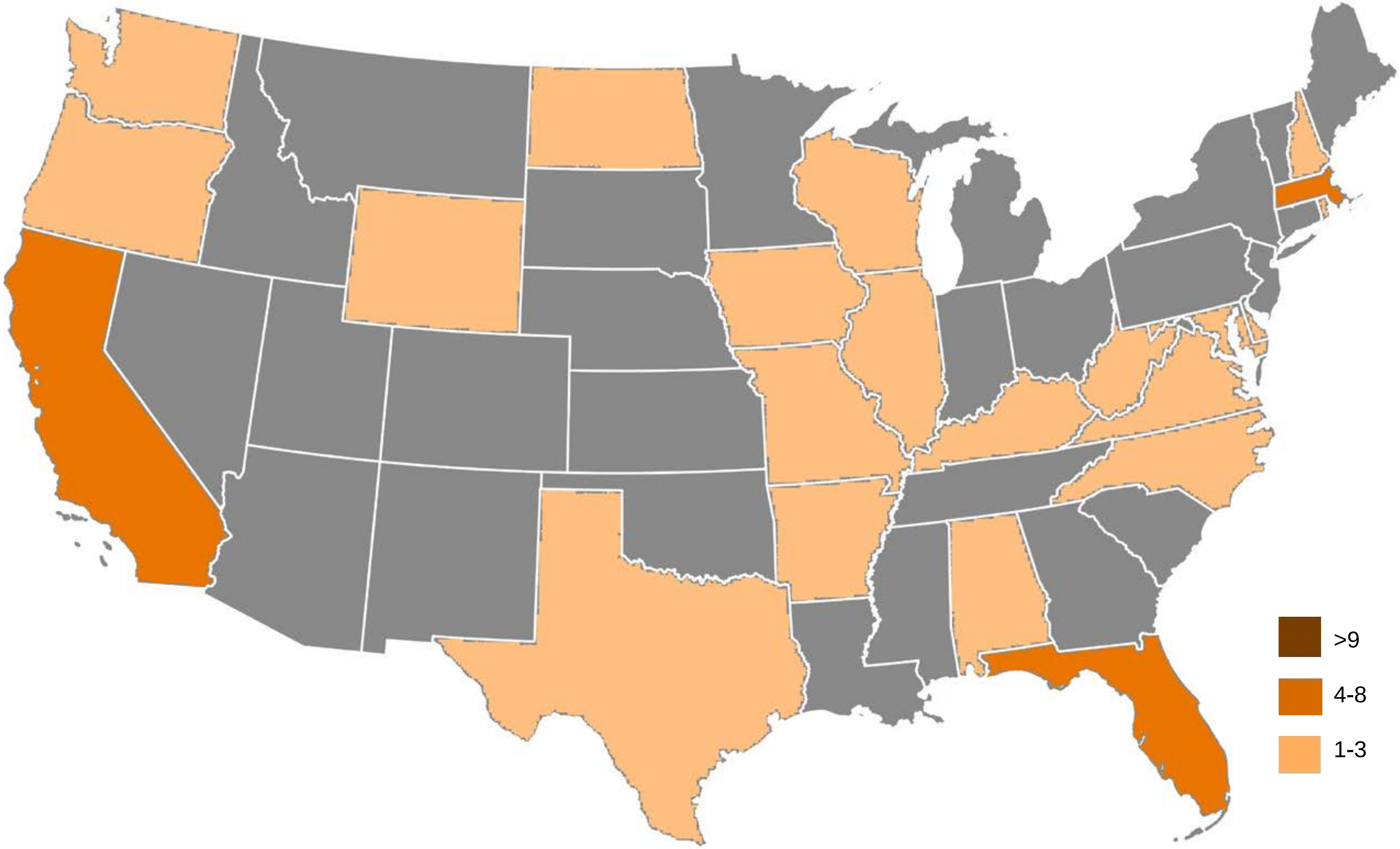
☑ TA 12 MATERIALS, STRUCTURES, MECHANICAL SYSTEMS, AND MANUFACTURING

TA 13 GROUND AND LAUNCH SYSTEMS

TA 14 THERMAL MANAGEMENT SYSTEMS

TA 15 AERONAUTICS

2016 Centennial Challenges Participant Teams



International participants from Mexico and Canada

PAST CHALLENGES

Challenges and Winners 2007-2011

Personal Air Vehicle

Opened: 2007

Closed: 2007

Winners: 3

Total awarded: $250,000

Astronaut Glove

Opened: 2007

Closed: 2009

Winners: 3

Total awarded: $550,000

Follow-up: Final Frontier Design awarded contract with NASA in 2016

Power Beaming

Opened: 2005

Closed: 2009

Winners: 1

Total awarded: $900,000

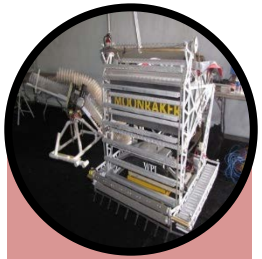
General Aviation

Opened: 2008

Closed: 2008

Winners: 3

Total awarded: $97,000



Regolith Excavation

Opened: 2007

Closed: 2007

Winners: 3

Total awarded: $750,000

Lunar Lander

Opened: 2007

Closed: 2009

Winners: 4

Total awarded: $2M

Follow-up: Masten Space Systems awarded contracts with NASA in 2010 and 2011

Green Flight

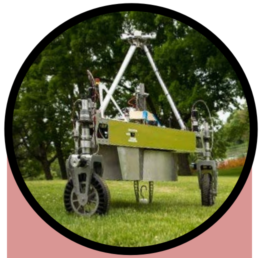
Opened: 2005

Closed: 2009

Winners: 2

Total awarded: $1.47M

Challenges and Winners 2012-2016



Sample Return Robot

Opened: 2012

Closed: 2016

Winners: 9

Total awarded:
$885,000

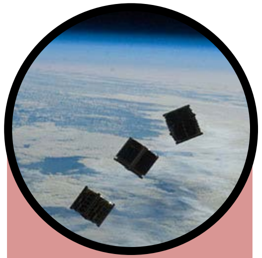
Mars Ascent Vehicle

Opened: 2014

Closed: 2016

Winners: 5

Total awarded:
$90,000



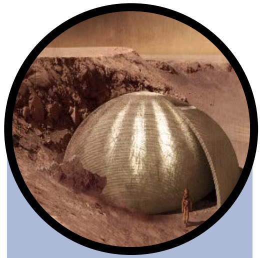
Cube Quest

Opened: 2014

Closed:
Ongoing

Winners: 10

Total awarded:
$250,000



3D-Printed Habitat

Phase 1
Opened: 2015

Closed: 2015

Winners: 3

Total awarded:
$97,000

Phase 2
Opened: 2016

Closed:
Ongoing

CURRENT CHALLENGES

What will home look like ... on Mars?

www.nasa.gov/**3DPHab**

3D-PRINTED HABITAT CHALLENGE

WHY A 3D-PRINTED HABITAT CHALLENGE?

- **Existing 3D-Printing Technology…**
  - Is advanced mostly for small plastic items
  - Require advancements for recycled & in-situ material

- **Advanced 3D-Printing Technology for Mars Construction**
  - Needs larger systems for habitat printing
  - Requires binders for construction using Mars regolith and recycled material
  - Requires advancements in material composition technology

What if a long-distance call could reach a new world?

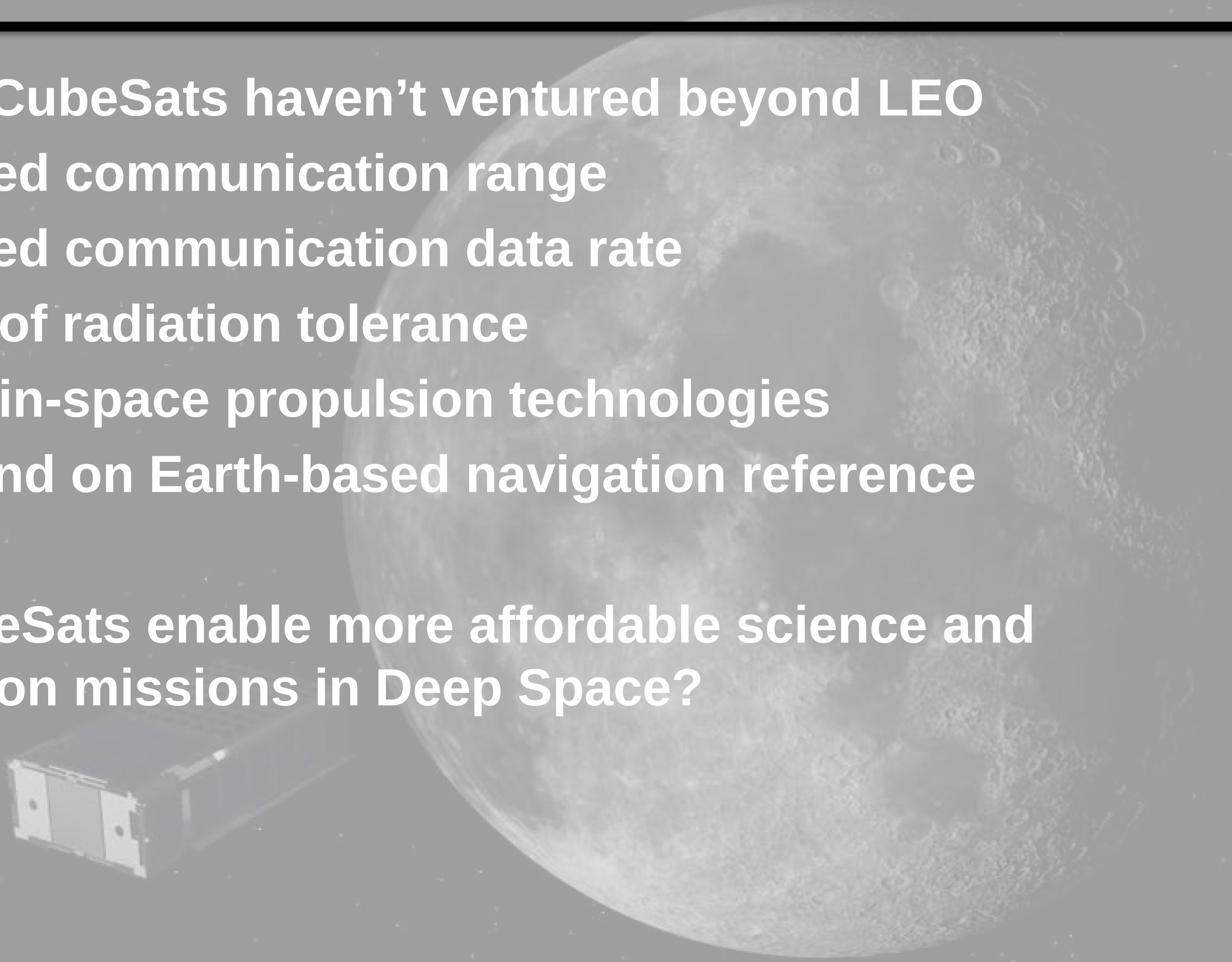
www.nasa.gov/**cubequest**

CUBE QUEST CHALLENGE

WHY A CUBE QUEST CHALLENGE?

- To date, CubeSats haven’t ventured beyond LEO
  - Limited communication range
  - Limited communication data rate
  - Lack of radiation tolerance
  - Lack in-space propulsion technologies
  - Depend on Earth-based navigation reference

- Can CubeSats enable more affordable science and exploration missions in Deep Space?

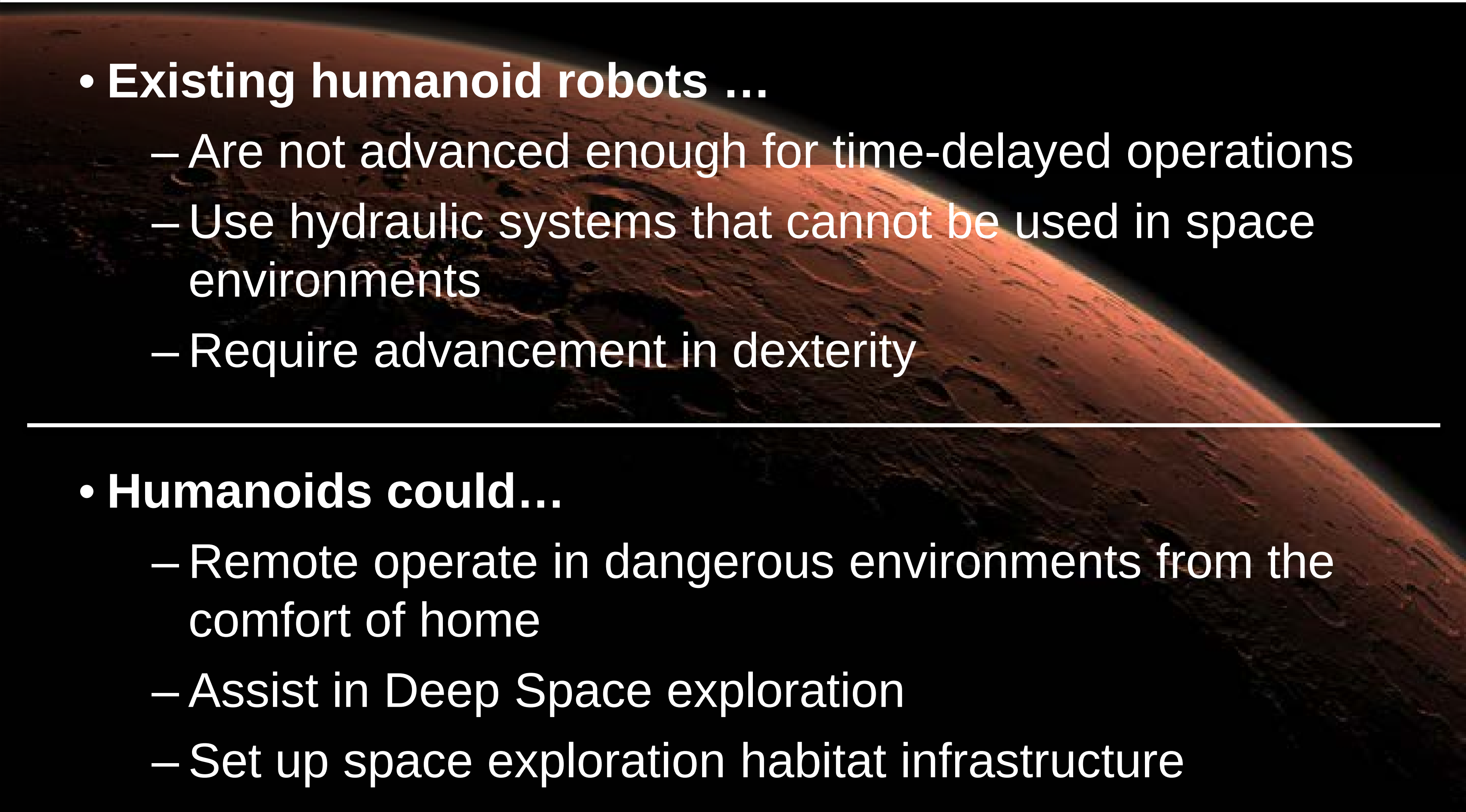


What if your coworkers came with batteries?

SPACE ROBOTICS CHALLENGE

www.nasa.gov/**spacebot**

WHY A SPACE ROBOTICS CHALLENGE?



- **Existing humanoid robots …**
  - Are not advanced enough for time-delayed operations
  - Use hydraulic systems that cannot be used in space environments
  - Require advancement in dexterity

- **Humanoids could…**
  - Remote operate in dangerous environments from the comfort of home
  - Assist in Deep Space exploration
  - Set up space exploration habitat infrastructure

What if space held the key to better health?

www.nasa.gov/**vtchallenge**

VASCULAR TISSUE CHALLENGE

WHY A VASULARIZATION CHALLENGE?

- Vascularization is one of the great challenges that tissue engineering faces in order to achieve sizeable tissue and organ substitutes that contain living cells.

- Tissue or organ substitutes in which any dimension, such as thickness, exceeds 400 μm needs to be vascularized to ensure cellular survival.

- Advancing the Technology Could:
  - <u>Enable</u> and <u>accelerate</u> <u>studies</u> of the effects of space radiation exposure, cancer biology and drug efficacy on human cells in space
  - Support the study of <u>regeneration and repair of human tissues</u>
  - Encourages commercial interest

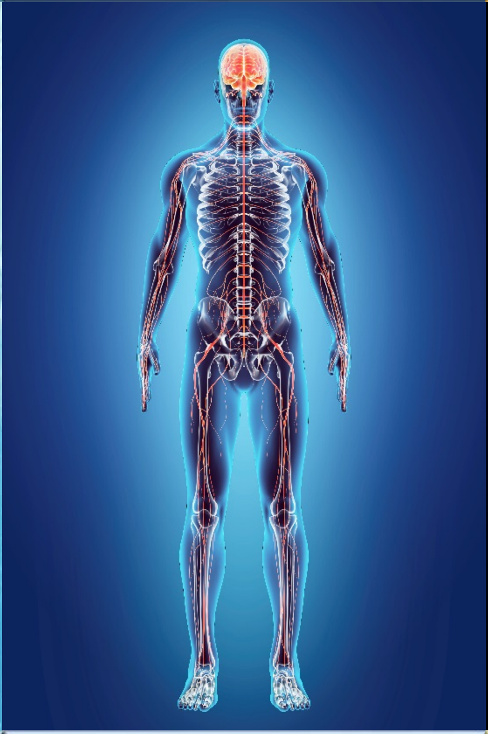
Cube Quest

Innovation in Small Spacecraft Propulsion + Communications

Objective: Design, build, and deliver flight-qualified, small satellites (CubeSats) capable of advanced operations near and beyond the moon.

Vascular Tissue

Growth of Vascularized Major Organ Tissues



Objective: Produce viable thick-tissue assays that can be used to advance research on earth, the ISS National Laboratory and Deep Space.

Space Robotics

Improve Humanoids Autonomous Perception + Manipulation

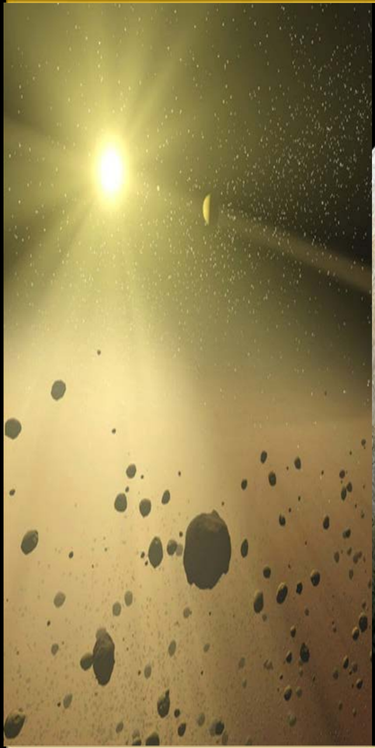
Objective: Advance robotic software that increases the autonomy of dexterous humanoid robots on Mars and beyond.

3D-Printed Habitat

Autonomous, Sustainable Additive Manufacturing of Habitats

Objective: Advance additive construction technology needed to create sustainable housing solutions for Earth and beyond.

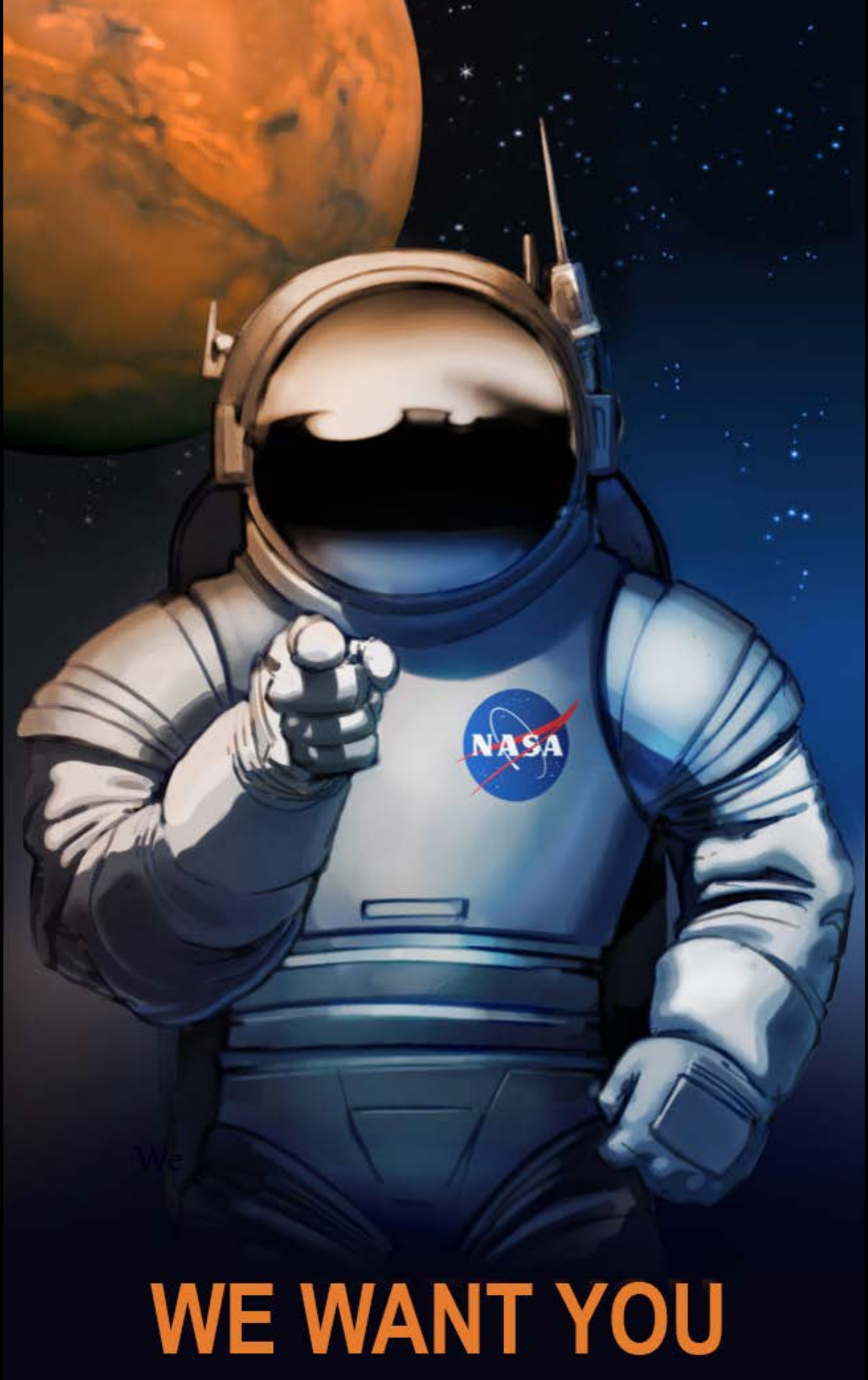
Challenges in Development

Asteroid Redirect	Detection of Life	$C0_2$ Conversion	Mars House
			
Sample an Asteroid?	Is there life On Europa?	CO_2 can be used to make WHAT?	Where will your toothpaste come from?

Sustainable House on Mars:

Can we live without resupplies from Earth?

OXYGEN • WASTE • FOOD • CLOTHING • POWER • HYGIENE PRODUCTS • MEDICINE • FUEL • BUILDING MATERIALS •


NASA
We
WE WANT YOU

Questions?